Dynamics of bacterial-phytoplanktonic systems influenced by eutrophication

G. TSIRTSIS, M. GIOKA, E. PANAGOPOULOU and P. VOUROS

Department of Environmental Studies, University of the Aegean, MYTILINI (Greece)

The fluctuations of heterotrophic bacterial number depends on the availability of organic matter resulting from sewage effluents and planktonic excretions (1). The study of such relationships in the marine ecosystem is complicated and therefore the use of microcosm systems can be useful in understanding heterotrophic processes. In the present work, the interactions between phytoplankton, heterotrophic bacteria and dissolved organic matter (DOM) was studied in the laboratory.

The marine alga *Dunaliella tertiolecta* was used for the experiments. Methodological details have been given in a previous work (2). The cultures were enriched during the exponential phase with sewage effluent after filtration and sterilization. Phytoplankton cell number, heterotrophic bacterial cell number, COD and organic nitrogen were measured every three days for two weeks.

Table 1: Phytoplankton-bacterial division rate (r) and carrying capacity (k) (cultures in 2 replicates)

Treatment	r (divisions/day)		k (cells/ml x 10^5)	
	Phyt.	Het.bact.	Phyt.	Het.bact.
Control culture	1.2 ± 0.4 1.1 ± 0.6	1.1 ± 0.5 0.9 ± 0.8	36 ± 2 37 ± 3	600 ± 70 560 ± 30
Add. of sew.eff.	1.2 ± 0.4 1.2 ± 0.5	2.1 ± 0.7 1.3 ± 0.7	42 ± 8 41 ± 7	870 ± 80 480 ± 30

FIGURE 1

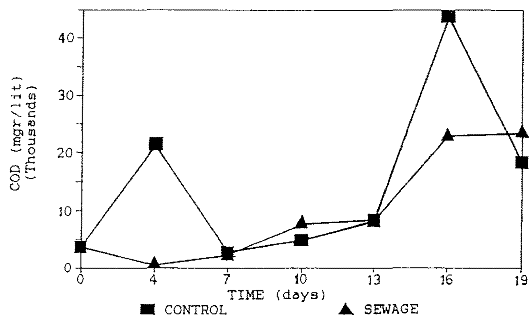
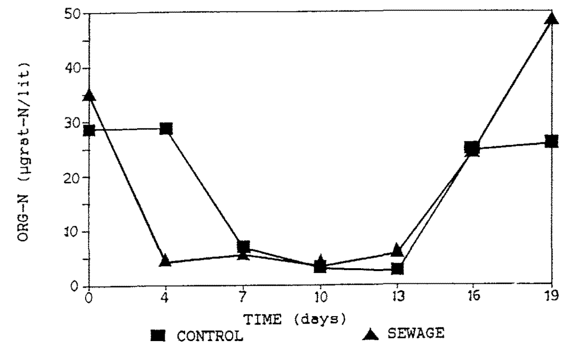


FIGURE 2



It was observed that division rates in heterotrophic bacteria were higher in the presence of sewage effluent (Table 1). The algal carrying capacity was also found increased in the presence of the effluent. COD showed an increase after the 13th day of growth (Fig. 1). The trend observed in organic nitrogen was different (Fig. 2); the available organic nitrogen was decreasing during the first week probably due to the bacterial uptake. The logarithms of heterotrophic bacterial number and organic nitrogen were highly correlated until the 13th day of the culture, with a negative correlation coefficient of 0. 77 for the control and 0. 90 for the other treatment. The low organic nitrogen levels (7th-13th day) were followed by an increase which may be associated with the senescence of the algal culture. The logarithms of phytoplankton and heterotrophic bacterial cell numbers were highly correlated with a linear relation. The correlation coefficient was found 0. 96 for the control and 0. 98 for the other treatment.

The dynamics between organic nitrogen and phytoplankton-bacterial growth is being investigated using mathematical modelling.

Acknowledgement

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Chlorophyll distribution throughout the Levantine Basin

Yosef Z. YACOBI[1], Tamar ZOHARY[1], Richard D. ROBARTS[2] and Marley WAISER[2]

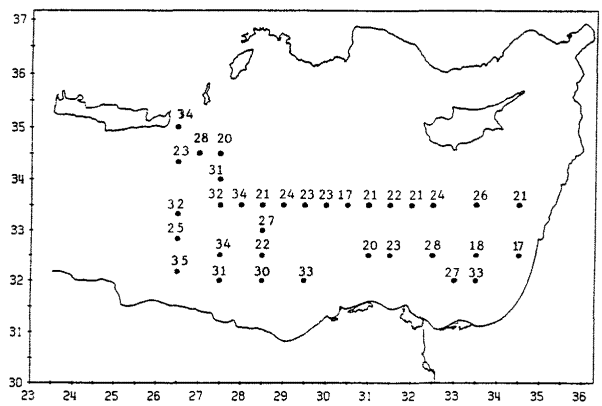
[1]Yigal Allon Kinneret Limnological Laboratory, Israel Oceanographic & Limnological Research, TIBERIAS (Israel)

[2]National Hydrology Research Center, Environment Canada, Saskatoon, SASKATCHEWAN (Canada)

The vertical distribution of chlorophyll a in the upper 200 m of the water column was recorded throughout the Levantine Basin of the Eastern Mediterranean (Fig. 1), as part of the autumn 1991 POEM Multinational Program. Chlorophyll a concentration (determined fluorometrically on duplicate extracts in the upper 200 m ranged from 9.2 to 423 ng l^{-1}, with an overall mean of 126 ± 85. 6 (SD) ng l^{-1}. In 5 stations chlorophylls were determined on water samples from 300 m. The concentrations ranged from 3.3 to 18.8 ng l^{-1}. These concentrations fall within previously reported (AZOV, 1986; BERMAN *et al.*, 1986; KIMOR *et al.*, 1987; SALIHOGLU *et al.*, 1990) ranges for the pelagic water of the Eastern Mediterranean. The vertical distribution of chlorophyll was close to uniform throughout the basin, with a prominent deep chlorophyll maximum (DCM) of about 250 ng l^{-1} at 90-110 m, corresponding with the depth to which about 1% of the incident light penetrated. Exceptions were two stations, located approximately within the Marsa Matruh Gyre, in which a more even depth-distribution of chlorophyll was observed, with >100 ng l^{-1} extending down to 200 m depth and no distinct DCM. Integrated water column (0-200 m) chlorophyll content ranged between 17-35 μg m^{-2}, with higher values close to the African coast and in the western part of the Basin (Fig. 1). This pattern corresponded with Secchi transparencies that were generally shallower at the sites with higher chlorophyll content.

Water samples from 0, 50 and 100 m at the stations along latitude 33.30 N were fractionated on 2 μ and 10 μ polycellulose filters. More than 90% of the chlorophyll was confined to particles <10 μ and more than 50% was found in particles <2 μ. The proportion of chlorophyll in <2 μ particles increased with depth and exceeded 70% at 100 m depth. The pattern was similar at the different stations. Furthermore, in the upper 90 m of the water column acidified chlorophyll extract comprised about 60% of the native extracts, while at deeper depths this proportion gradually increased. This implies that pigments other than chlorophyll a, which contribute to the fluorescence of the acidified extract, became more abundant at the deeper depths. Such a pigment is chlorophyll b, which was found by HPLC analyses to be abundant in Eastern Meditteranean samples from DCM layers in September 1989 and October 1990 (YACOBI, unpublished data). The increase with depth in the contribution of small particles to chlorophyll concentrations, and the concomitant increasing proportion of acidified extract suggest that the chlorophyll b containing prochlorophytes dominate the DCM of the Levantine Basin, a hypothesis that needs confirmation.

Fig. 1. Station positions (circles) for IOLR POEM cruise (14 Oct-10 Nov 1991), and the distribution of depth-integrated (0-200 m) chlorophyll a concentration (μg m^{-2}; values above circles).



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